Data Evaluation Report of Hydrolysis

PMRA Submission Number {.....} EPA MRID Number 42917601

Data Requirement: PMRA Data Code: N/A
EPA DP Barcode: 330489
OECD Data Point: N/A
EPA Guideline: 161-1

Test material:
Common name:
Chemical name
IUPAC: (*R*)-2-(2,4-dichlorophenoxy)propionic acid
CAS name: (2*R*)-2-(2,4-dichlorophenoxy)propanoic acid
CAS No:
Synonyms:N/A
PC Code: 031465

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Date: 10-29-10

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Date: 10.04.10

Company Code:
Active Code:
Use Site Category:
PC Code: 0314465

CITATION:

Skinner, Wayne. 1993. Hydrolysis of Optically Active [^{14}C-2-2,4-Dichlorophenoxy) Propionic Acid 2-Ethylhexyl Ester at pH 5, 7, and 9. Performed by PTRL West, Inc., Richmond, CA. Submitted by 2,4- DP(1988) Task Force, BASF, Germany. MRID 42917601.

EXECUTIVE SUMMARY:

The study provides acceptable data on abiotic hydrolysis of 2,4-DP-p 2-ethylhexyl ester (2,4-DP EHE) in pH 5, 7, and 9 buffer solutions. This study, in conjunction with the soil slurry study of 2,4-DP EHE (MRID 429370-06) provides adequate environmental fate bridging data to link 2,4-DP EHE degradation to 2,4-DP-p acid formation. No additional data are needed at this time.

The abiotic hydrolytic half-life of 2,4-DP EHE was 445 days ($k=-0.0016$ days^{-1}) in pH 5 buffer solution, 312 days ($k=0.002$ days^{-1}) in pH 7 buffer solution, and 13.98 days ($k=-0.0496$ days^{-1}) in pH 9 buffer solution. The hydrolytic half-lives of 2,4-DP-p EHE in pH 5 and 7 buffer solutions are only approximations because they were estimated by data extrapolation. The major degradate was identified as 2,4-DP-p acid.

The reported data indicate that 2,4-DP EHE will hydrolyze in alkaline aquatic environments (pH=9). However, 2,4-DP EHE does not undergo rapid abiotic hydrolysis in neutral and acidic aquatic environments.

MATERIALS AND METHODS:

Preliminary Study

A. preliminary study was conducted to evaluate adsorption of 2,4-DP-p acid 2-ethylhexyl ester (2,4-DP-EHE) to borosilicate glass surfaces. Sterile buffer solutions were amended with radiolabeled 2,4-DP-EHE to yield nominal concentrations of 41 and 84 µg/L. Each fortified solution was placed into each of three borosilicate glass vessels and then incubated for 0.6, 24, and 48 hours.

Definitive Study

Sterile buffer solution (acetate, pH=5; phosphate, pH=7; borate, pH=9) were each amended with [^{14}C]-2-(2,4-dichlorophenoxy) propionic acid 2-ethylhexyl ester (ring-labeled; SA=1.5 MBq/mg; radiopurity = 95.6%) to yield a nominal solution concentration of 86 µg/L. [Scientist Note: The reported water solubility of 2,4-DP EHE is approximately 170 µg/L.] The final concentration of the co-solvent (acetonitrile) was 1%.

An aliquot (100 ml) of each fortified buffer solution was dispensed into each of twelve 125 ml glass bottles, The bottles were capped and incubated in the dark at 25^{o}C. Duplicate samples were taken at immediately post-treatment, 3, 7, 14, 20, and 30 days post-treatment.

Analytical

The pH of each sample was recorded and then the solutions were acidified (pH 2-4) with HCl before chemical analysis. The glass incubation bottles were rinsed with acetonitrile to remove 2,4-DP-EHE adhering to glass surfaces. The ^{14}C content in the rinsate was determined by LSC.

Soluble residues were separated using 2D-TLC with toluene/ethyl acetate/acetic acid 10:1:1 (v:v:v) and hexane/2-propanol 1:8(v:v) with 5% acetic acid solvent systems. Soluble residues were also separated by HPLC equipped with either a 018533AG or D18569AG column and a linear solvent system of acetonitrile:HPLC grade H_2O:1% trifluoroacetic acid in HPLC water; and separated residues were detected by UV (254-255 nm) and radioactivity detectors. HPLC eluent was collected by a fraction collector at 0.5 minute intervals. Separated residues were identified by co-chromatgraphy with known standards. The ^{14}C content in buffer solutions and HPLC eluent were determined by LSC. The detection limits (LOD) and limit of quantification (LOQ) for LSC were 0.25% of applied and 0.875% of applied, respectively.

RESULTS AND DISCUSSION:

A. Preliminary studies indicate that 2,4-DP EHE sorbs to borosilicate glass. The extent of 2,4-DP EHE sorption on borosilicate glass ranged from 13 to 19% (41 to 84 µg/L) of applied at 2,4-DP EHE.

B. Material balance of radiolabeled residues accounted for 86 to 107% of applied 2,4-DP EHE in pH 5, 7, and 9 buffer solutions (Tables III, IV, and V) .

C. The abiotic hydrolytic half-life of 2,4-DP EHE was 445 days (r^2=0.83; k= days-^{1}) in pH 5 buffer solution, 312 days (r^2 =0.88; k= days- 1) in pH 7 buffer solution, and 13.98 days {r^2 =0.96; k= days-1) in pH 9 buffer solution (Figures 11, 12, and 13). [**Reviewer Note**: The abiotic hydrolysis half-lives at pH 5 and 7 are approximated because they were estimated by data extrapolation.]

D. The major hydrolytic degradate of 2,4-DP EHE was identified as 2,4- DP-P acid. This degradate accounted for 76.2% of the applied radioactivity at 30 days post-treatment in pH 9 buffer solution (Table VI to VIII). Five unidentified peaks (4.9 to 6.1% of applied dose) were detected in the HPLC chromatograms.

REVIEW COMMENTS:

A. The registrant used litmus paper to evaluate pH of the buffer solutions during the study. EFED believes litmus paper provides only a semi-quantitative measure of pH. In future studies, the registrant should use a pH meter with the appropriate electrode.

B. The hydrolysis half-life of 2,4-DP-p EHE is based on the soluble fraction of 2,4-DP EHE. EFED believes the hydrolysis data will not be jeopardized by estimation of hydrolytic degradation of soluble 2,4-DP EHE because the hydrolysis data clearly indicate that 2,4-DP EHE degradation is controlled alkaline catalyzed hydrolysis. No additional information or data are needed at this time.

C. The registrant did not analyze the buffer solutions for 2-ethylhexanol. EFED believes that 2-ethylhexanol should be formed from hydrolytic degradation of 2,4-DP EHE.

Table III. Material Balance Following the Aqueous Hydrolysis of [^{14}C] 2,4-DP-p 2-EHE at pH 5.

Sample	DPM Applied	PPB	Recovered (DPM and % of Applied Dose) in: Buffer Plus Initial Rinse		Additional Rinse		Total Recovery [a]	
			DPM	%	DPM	%	DPM	%
Day 0								
Replicate (A)	821547	86	885828	107.8	200	0.0 [b]	886028	107.8
Replicate (B)	821547	86	856917	104.3	400	0.0 [b]	857317	104.4
Average							871673	106.1
Day 3								
Replicate (A)	821547	86	761784	92.7	1066	0.1 [b]	762850	92.9
Replicate (B)	821547	86	805621	98.1	0	0.0 [b]	805621	98.1
Average							784236	95.5
Day 7								
Replicate (A)	821547	86	778475	94.8	5724	0.7 [c]	784199	95.5
Replicate (B)	821547	86	723700	88.1	4780	0.6 [c]	728480	88.7
Average							756340	92.1
Day 14								
Replicate (A)	821547	86	720832	87.7	9793	1.2 [c]	730625	88.9
Replicate (B)	821547	86	775125	94.3	11197	1.4 [c]	786322	95.7
Average							758474	92.3
Day 21								
Replicate (A)	821547	86	867989	105.7	1307	0.2 [c]	869296	105.8
Replicate (B)	821547	86	776599	94.5	4431	0.5 [c]	781030	95.1
Average							825163	100.4
Day 30								
Replicate (A)	821547	86	735124	89.5	4852	0.6 [c]	739976	90.1
Replicate (B)	821547	86	726105	88.4	10149	1.2 [c]	736254	89.6
Average							738115	89.8

a. Overall average recovery ± S.D. for all pH 5 samples is 96.1 ± 6.7 % of applied radiocarbon.
b. Additional rinse of container employed 10 mL of 0.5 M NaOH for 0 and 3 day samples.
c. Additional rinse of container employed 10 mL of acetone for 7, 14, 21, and 30 day samples.

Table IV. Material Balance Following the Aqueous Hydrolysis of [^{14}C] 2,4-DP-p 2-EHE at pH 7.

Sample	DPM Applied	PPB	Recovered (DPM and % of Applied Dose) in: Buffer Plus Initial Rinse		Additional Rinse		Total Recovery [a]	
			DPM	%	DPM	%	DPM	%
Day 0								
Replicate (A)	821547	86	811162	98.7	416	0.1 [b]	811578	98.8
Replicate (B)	821547	86	760748	92.6	538	0.1 [b]	761286	92.7
Average							786432	95.7
Day 3								
Replicate (A)	821547	86	796897	97.0	0	0.0 [b]	796897	97.0
Replicate (B)	821547	86	828780	100.9	1692	0.2 [b]	830472	101.1
Average							813685	99.0
Day 7								
Replicate (A)	821547	86	764537	93.1	10715	1.3 [c]	775252	94.4
Replicate (B)	821547	86	789305	96.1	9609	1.2 [c]	798914	97.2
Average							787083	95.8
Day 14								
Replicate (A)	821547	86	722531	87.9	20568	2.5 [c]	743099	90.5
Replicate (B)	821547	86	769919	93.7	9201	1.1 [c]	779120	94.8
Average							761110	92.6
Day 21								
Replicate (A)	821547	86	813473	99.0	5951	0.7 [c]	819424	99.7
Replicate (B)	821547	86	806777	98.2	4806	0.6 [c]	811583	98.8
Average							815504	99.3
Day 30								
Replicate (A)	821547	86	795739	96.9	3066	0.4 [c]	798805	97.2
Replicate (B)	821547	86	706842	86.0	2639	0.3 [c]	709481	86.4
Average							754143	91.8

a. Overall average recovery ± S.D. for all pH 7 samples is 95.7 ± 4.2 % of applied radiocarbon.
b. Additional rinse of container employed 10 mL of 0.5 M NaOH for 0 and 3 day samples.
c. Additional rinse of container employed 10 mL of acetone for 7, 14, 21, and 30 day samples.

Table V. Material Balance Following the Aqueous Hydrolysis of [^{14}C] 2,4-DP-p 2-EHE at pH 9.

Sample	DPM Applied	PPB	Recovered (DPM and % of Applied Dose) in: Buffer Plus Initial Rinse		Additional Rinse		Total Recovery [a]	
			DPM	%	DPM	%	DPM	%
Day 0								
Replicate (A)	821547	86	803129	97.8	286	0.0 [b]	803415	97.8
Replicate (B)	821547	86	810265	98.6	402	0.0 [b]	810667	98.7
Average							807041	98.2
Day 3								
Replicate (A)	821547	86	825201	100.4	1269	0.2 [b]	826470	100.6
Replicate (B)	821547	86	794031	96.7	553	0.1 [b]	794584	96.7
Average							810527	98.7
Day 7								
Replicate (A)	821547	86	888573	108.2	21054	2.6 [c]	909627	110.7
Replicate (B)	821547	86	782692	95.3	9081	1.1 [c]	791773	96.4
Average							850700	103.5
Day 14								
Replicate (A)	821547	86	728035	88.6	4255	0.5 [c]	732290	89.1
Replicate (B)	821547	86	773730	94.2	6944	0.8 [c]	780674	95.0
Average							756482	92.1
Day 21								
Replicate (A)	821547	86	803051	97.7	2278	0.3 [c]	805329	98.0
Replicate (B)	821547	86	842578	102.6	0	0.0 [c]	842578	102.6
Average							823954	100.3
Day 30								
Replicate (A)	821547	86	797005	97.0	2654	0.3 [c]	799659	97.3
Replicate (B)	821547	86	855294	104.1	769	0.1 [c]	856063	104.2
Average							827861	100.8

a. Overall average recovery ± S.D. for all pH 9 samples is 98.9 ± 5.3 % of applied radiocarbon.
b. Additional rinse of container employed 10 mL of 0.5 M NaOH for 0 and 3 day samples.
c. Additional rinse of container employed 10 mL of acetone for 7, 14, 21, and 30 day samples.

Table VI. Radiocarbon Distribution for Hydrolysis of 2,4-DP-p 2-EHE in pH 5 Aqueous Buffers.

Sample	Rep	% of Applied Dose in pH 5 Solution	Distribution in pH 5 Buffer: From HPLC, % of ^{14}C in pH 5 Solution [a] as:			Distribution in pH 5 Buffer: % of Applied Dose as:		
			Ester [b]	Acid	Others	Ester	Acid	Others
Day 0	A	107.8	95.8	0.0	4.2	103.3	0.0	4.5
	B	104.3	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Average		106.1						
Day 3	A	92.7	95.4	0.0	4.6	88.4	0.0	4.3
	B	98.1	95.7	0.3	4.0	93.8	0.3	3.9
Average		95.4	95.5	0.2	4.3	91.1	0.2	4.1
Day 7	A	94.8	95.1	0.0	4.9	90.2	0.0	4.6
	B	88.1	96.5	0.0	3.5	85.0	0.0	3.1
Average		91.5	95.8	0.0	4.2	87.6	0.0	3.8
Day 14	A	87.7	95.2	0.0	4.8	83.5	0.0	4.2
	B	94.3	97.5	0.0	2.5	91.9	0.0	2.4
Average		91.0	96.3	0.0	3.7	87.7	0.0	3.3
Day 21	A	105.7	94.6	0.0	5.4	100.0	0.0	5.7
	B	94.5	93.9	0.7	5.5	88.7	0.6	5.2
Average		100.1	94.2	0.3	5.4	94.3	0.3	5.5
Day 30	A	89.5	92.4	1.7	5.9	82.7	1.5	5.3
	B	88.4	89.4	2.8	7.8	79.0	2.5	6.9
Average		89.0	90.9	2.3	6.8	80.9	2.0	6.1

a. Buffer plus initial test container rinse (5 mL ACN & 5 mL acetone).
b. These values used to estimate the hydrolytic half-life of 2,4-DP-p 2-EHE at pH 5.

Table VII. Radiocarbon Distribution for Hydrolysis of 2,4-DP-p 2-EHE in pH 7 Aqueous Buffers.

Sample	Rep	% of Applied Dose in pH 7 Solution [a]	Distribution in pH 7 Buffer: From HPLC, % of ^{14}C in pH 7 Solution [a] as: Ester [b]	Acid	Others	% of Applied Dose as: Ester	Acid	Others
Day 0	A	98.7	95.7	0.0	4.3	94.5	0.0	4.2
	B	92.6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Average		95.7						
Day 3	A	97.0	95.5	0.5	4.0	92.6	0.5	3.9
	B	100.9	96.6	0.0	3.4	97.5	0.0	3.4
Average		99.0	96.1	0.3	3.7	95.1	0.2	3.6
Day 7	A	93.1	95.8	1.3	2.8	89.2	1.2	2.6
	B	96.1	94.4	0.9	4.6	90.8	0.9	4.5
Average		94.6	95.1	1.1	3.7	90.0	1.1	3.5
Day 14	A	87.9	96.2	1.2	2.6	84.5	1.1	2.3
	B	93.7	96.3	1.1	2.6	90.2	1.1	2.4
Average		90.8	96.2	1.2	2.6	87.4	1.1	2.4
Day 21	A	99.0	90.8	3.9	5.3	89.9	3.8	5.3
	B	98.2	91.7	3.7	4.6	90.0	3.7	4.5
Average		98.6	91.2	3.8	5.0	90.0	3.7	4.9
Day 30	A	96.9	91.2	4.0	4.8	88.3	3.9	4.7
	B	86.0	89.1	5.1	5.9	76.6	4.3	5.0
Average		91.5	90.1	4.5	5.4	82.5	4.1	4.9

a. Buffer plus initial test container rinse (5 mL ACN & 5 mL acetone).
b. These values used to estimate the hydrolytic half-life of 2,4-DP-p 2-EHE at pH 7.

Table VIII. Radiocarbon Distribution for Hydrolysis of 2,4-DP-p 2-EHE in pH 9 Aqueous Buffers.

Sample	Rep	% of Applied Dose in pH 9 Solution [a]	Distribution in pH 9 Buffer: From HPLC, % of ^{14}C in pH 9 Solution [a] as: Ester [b]	Acid	Others	% of Applied Dose as: Ester	Acid	Others
Day 0	A	97.8	95.7	0.0	4.3	93.6	0.0	4.2
	B	98.6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Average		98.2						
Day 3	A	100.4	81.8	14.6	3.6	82.1	14.6	3.6
	B	96.7	92.1	1.2	6.7	89.1	1.2	6.5
Average		98.6	87.0	7.9	5.2	85.6	7.9	5.1
Day 7	A	108.2	63.5	34.7	1.8	68.7	37.5	2.0
	B	95.3	61.0	30.5	8.5	58.1	29.0	8.1
Average		101.8	62.3	32.6	5.2	63.4	33.3	5.1
Day 14	A	88.6	37.5	56.5	6.0	33.2	50.1	5.3
	B	94.2	44.1	52.6	3.3	41.6	49.5	3.1
Average		91.4	40.8	54.6	4.6	37.4	49.8	4.2
Day 21	A	97.7	33.0	62.1	4.9	32.2	60.7	4.8
	B	102.6	57.4	36.2	6.4	58.9	37.2	6.6
Average		100.2	45.2	49.2	5.7	45.5	48.9	5.7
Day 30	A	97.0	17.9	77.0	5.1	17.4	74.7	5.0
	B	104.1	19.3	74.7	6.1	20.0	77.8	6.3
Average		100.6	18.6	75.8	5.6	18.7	76.2	5.6

a. Buffer plus initial test container rinse (5 mL ACN & 5 mL acetone).
b. These values used to estimate the hydrolytic half-life of 2,4-DP-p 2-EHE at pH 9.

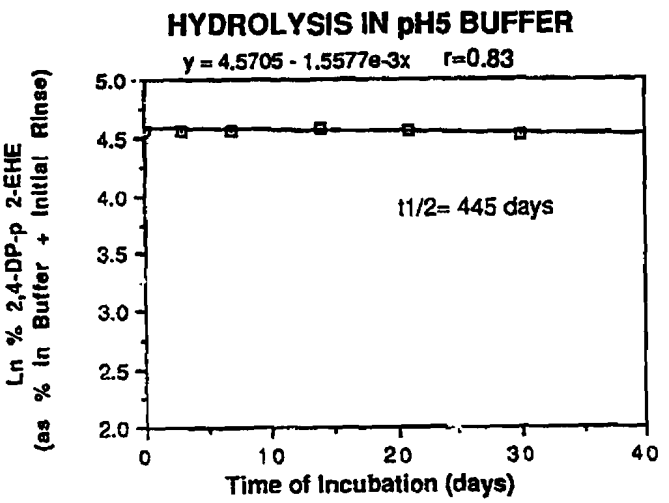

Figure 11. Hydrolysis Degradation Rate of [^{14}C]2,4-DP-p 2-EHE at pH 5 (Based on Table VI).

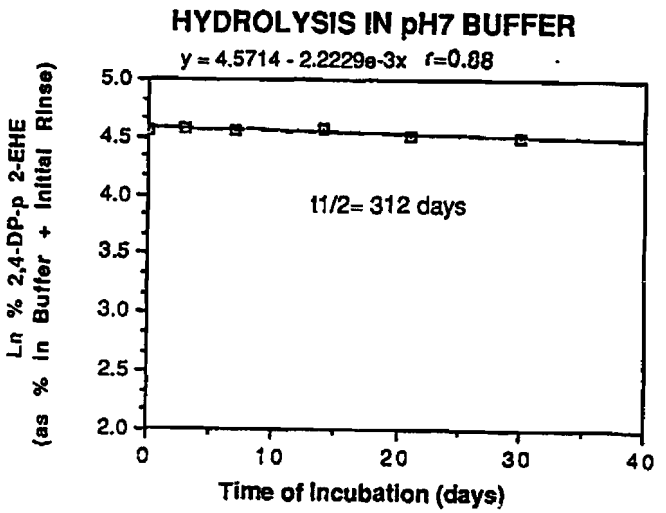

Figure 12. Hydrolysis Degradation Rate of [^{14}C]2,4-DP-p 2-EHE at pH 7 (Based on Table VII).

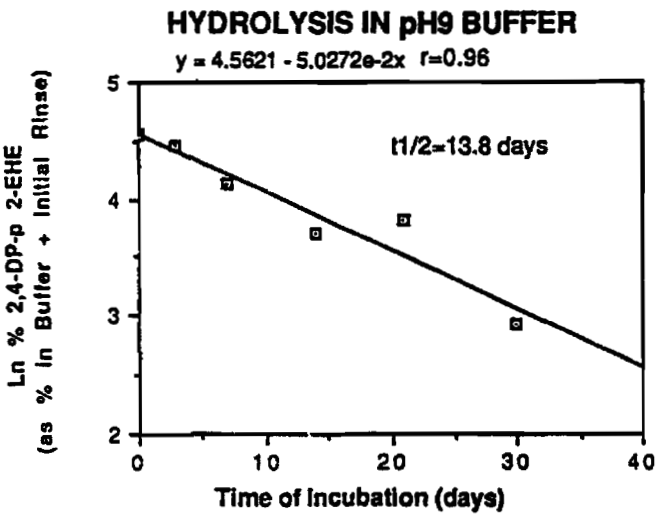

Figure 13. Hydrolysis Degradation Rate of [^{14}C]2,4-DP-p 2-EHE at pH 9 (Based on Table VIII).